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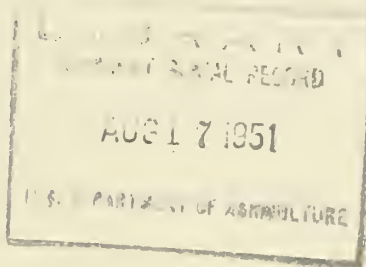
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Report on Vacuum Cooling of Lettuce
Salinas, Calif., June 13 - 15, 1949

By

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Report of a study in which certain
phases were carried on under the Research
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Division of Fruit and Vegetable Crops and Diseases

Report on Vacuum Cooling of Lettuce,
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Introduction and Description of Equipment

This report on the vacuum cooling of lettuce is the result of tests performed in Salinas, California, at the Vacuum Cooling Company. All of the tests were made on lettuce destined for the commercial market.

The vacuum chamber was made of 1/2" steel plate and measured approximately 6 feet in diameter and 30 feet in length. It had a capacity of one-half of a standard refrigerator carload or 150 crates. It is operated through the use of steam ejectors for building up the vacuum, and a barometric condensor for the final stage.

Operation Methods

Lettuce which is going to be cooled by the vacuum method is dry packed in a standard lettuce crate, which holds 4-5 doz. heads and weighs approximately 70 pounds.

After the lettuce is packed and the crate securely lidded, the crates are wheeled into the vacuum chamber on small, flat cars with slatted bottoms. When the chamber is full, the door is closed and securely fastened to eliminate leakage. The chamber is then brought to a vacuum of approximately 29.7 in. mercury in about 15 minutes. The actual cooling of the lettuce begins when a reading of approximately 29.0 is attained, but doesn't reach appreciable amounts until 29.7 in. is reached. Once the lettuce starts to cool, the temperature drops rapidly, the actual cooling process involving approximately 30-35 minutes.

The entire operation, including evacuation and final cooling, takes about 50 - 55 minutes.

Results

The results of the test can best be ascertained by comparing the figures from Tables 1 - 5 with those of Table 6. By doing this, it can be seen that a reduction of approximately 30.0° F. occurred when the lettuce was subjected to vacuum cooling. The internal temperature of the cooled heads averaged about 32.5° - 33.0° F., and the surface was about 1/2 of a degree lower. Table No. 7 gives the rate of temperature change of the lettuce during the cooling process. As can be seen, the rate of cooling is quite rapid at first, becoming slower as the temperature is lowered. The figures also indicate that a little faster cooling can be obtained towards the middle of the chamber than at the door.

The lettuce was inspected for possible damage due to freezing, wilting, etc., following the completion of the cooling operation. No damage was found. If anything, the heads had a better appearance for the leaves were crisper than before being cooled.

Commercial Application

Vacuum cooled lettuce was first shipped from Salinas in 1948 when a few cars were sent to the eastern market. This year several more carloads have been shipped east, and the prospect for continued shipments of vacuum cooled lettuce is favorable.

By the use of this method of cooling, the need for icing the individual crate, i.e., package ice, is eliminated. Most of the carloads of vacuum cooled lettuce have gone east without top-icing and apparently suffered no ill effects.

The general recommendation for rail shipments of vacuum cooled lettuce are: (1) that the car be pre-cooled; (2) if the car is equipped with fans that the fans be on; (3) that the car be pre-iced and 2% salt, bunker capacity, added; (4) that it be sent standard refrigeration.

The cost of vacuum cooling of lettuce as compared with ice-packaging is somewhat cheaper. At present prices the cost of ice-packing is \$1.65 per crate, while dry pack costs about \$1.05 per crate and vacuum cooling \$0.25 per crate, giving a total of \$1.30. This represents a saving of \$0.35 per crate through use of the vacuum cooling method.

A Ryan recording thermometer was installed in one car in the top layer at the doorway. It was shipped standard refrigeration, no top ice, fans on, to Cleveland, Ohio. When returned, the temperature record of this car, which was precooled to about 33°, will be attached to this report.

Table No. 1

Lettuce Head Temperature after Cooling in Chamber, June 13, 1949.

PFE 6818

Cooling Time - 35 minutes at 29.7 in. Mercury

Position of Crate	Position of Lettuce in crates tested	Temperature after cooling <u>1/</u>
1. Top layer near door of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 31.6° F. 2. 31.6° F. 3. 35.0° F. 4. 31.4° F. 5. 33.8° F.
2. Top layer near middle of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 31.9° F. 2. 32.6° F. 3. 31.5° F. 4. 31.5° F. 5. 32.0° F.
3. Top layer at rear of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 32.0° F. 2. 32.7° F. 3. 32.7° F. 4. 32.0° F. 5. 33.5° F.

1/ Thermocouples inserted into lettuce heads approximately 1-1/2 inches toward the center of the head, and above temperatures correspond to that position.

Table No. 2

Lettuce Head Temperature after Cooling in Chamber, June 15, 1949.

PFE 6818

Cooling Time - 50 minutes at 29.7 in. Mercury

Position of Crate	Position of lettuce in crates tested	Temperature after cooling <u>1</u> /
1. Middle layer near door of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 33.5° F. 2. 34.0° F. 3. 33.7° F. 4. 34.0° F. 5. 34.0° F.
2. Middle layer near middle of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. do. do.	1. 35.0° F. 2. 35.0° F. 3. 36.4° F. 4. 36.1° F. 5. 36.0° F.
3. Middle layer at rear of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 35.0° F. 2. 35.9° F. 3. 35.1° F. 4. 36.0° F. 5. 36.2° F.

1/ Thermocouples inserted into lettuce heads approximately 2 inches, and above temperatures correspond to that position.

Table No. 3

Lettuce Head Temperature after Cooling in Chamber, June 15, 1949

PFE 6818

Cooling Time - 31 minutes at 29.7 in. Mercury

Position of Crate	Position of Lettuce in crates tested	Temperature after cooling <u>1/</u>
1. Middle layer near door of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 32.5° F. 2. 33.0° F. 3. 32.0° F. 4. 32.0° F. 5. 32.2° F.
2. Middle layer near middle of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 31.7° F. 2. 30.9° F. 3. 31.2° F. 4. 33.5° F. 5. 32.6° F.
3. Middle layer at rear of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 32.6° F. 2. 32.6° F. 3. 33.0° F. 4. 33.0° F. 5. 31.5° F.

1/ Thermocouples inserted into lettuce head approximately 1-1/2 inches toward the center of the head and above temperatures correspond to that position.

Table No. 4

Lettuce Head Temperatures after Cooling in Chamber, June 15, 1949

PFE 4173

Cooling Time - 31 minutes at 29.7 in. Mercury

Position of Crate	Position of lettuce in crates tested	Temperature after cooling <u>1/</u>
1. Middle layer near door of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 33.5° F. 2. 33.6° F. 3. 32.5° F. 4. 32.5° F. 5. 32.5° F.
2. Middle layer near middle of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 33.3° F. 2. 32.4° F. 3. 33.3° F. 4. 34.2° F. 5. 33.9° F.
3. Middle layer at rear of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 32.6° F. 2. 33.5° F. 3. 34.1° F. 4. 33.0° F. 5. 33.5° F.

1/ Thermocouples inserted into lettuce heads approximately 2-1/2 inches towards the center of the head and above temperatures correspond to that position.

Table No. 5

Lettuce Head Temperature after Cooling in Chamber, June 15, 1949.

PFE 4173

Cooling Time - 31 minutes at 29.7 in. Mercury

Position of Crate	Position of lettuce in crates tested	Temperature after cooling <u>1</u> /
1. Middle layer near door of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 33.4° F. 2. 32.0° F. 3. 33.0° F. 4. 31.2° F. 5. 31.2° F.
2. Middle layer near middle of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. do. do.	1. 32.0° F. 2. 33.8° F. 3. 31.5° F. 4. 32.2° F. 5. 32.9° F.
3. Middle layer at rear of vacuum chamber	1. Top layer 2. Middle layer 3. do. do. 4. do. do. 5. Bottom layer	1. 32.5° F. 2. 32.5° F. 3. 32.0° F. 4. 33.5° F. 5. 31.8° F.

1/ Thermocouples inserted into lettuce head approximately 2 inches toward the center of the head and above temperatures correspond to that position.

Table No. 6

Lettuce Head Temperatures Before Cooling in Chamber 1/
June 15, 1949

June 15, 1949 2/

1. 61.0° F.
2. 61.5°
3. 60.0°
4. 61.0°
5. 60.5°
6. 60.5°
7. 61.0°
8. 60.0°
9. 60.5°
10. 61.5°
11. 63.0°
12. 63.0°
13. 64.0°
14. 64.0°
15. 64.0°
16. 63.0°
17. 63.5°
18. 63.0°
19. 64.0°
20. 65.5°

June 13, 1949 3/

1. 70.4° F.
2. 65.5°
3. 63.6°
4. 69.5°
5. 66.1°
6. 67.0°
7. 70.0°
8. 69.5°
9. 65.8°
10. 66.5°

1/ The temperatures in this table were obtained by inserting ordinary mercury thermometers into the individual heads to a depth of approximately 1-1/2 - 2 inches; the heads picked at random throughout the load.

2/ Temperature for two full carloads.

3/ Temperature for one full carload.

Table No. 7

Temperature Changes in Unpackaged, but Crated, Lettuce
During Vacuum Cooling at 29.7 in. Mercury for 30 minutes.
June 15, 1949.

Door <u>1</u> /	2/5 way towards rear <u>2</u> /
Start = 61.1° F.	61.9° F.
1:30 = 61.1°	61.9°
1:35 = 60.6°	61.1°
1:38 = 58.5°	58.0°
1:41 = 51.6°	49.0°
1:44 = 49.9°	43.8°
1:47 = 43.5°	39.9°
1:50 = 41.2°	36.0°
1:53 = 38.4°	35.3°
1:56 = 37.9°	34.0°
1:59 = 35.7°	33.5°
2:02 = 34.9°	32.5°
2:05 = 33.6°	32.0°

1/ Thermocouple inserted into one lettuce head to a depth of approximately 2 inches. The head being tested was in the top layer within the crate, and the crate was in the top layer just behind the door of the chamber.

2/ Thermocouple inserted in lettuce head to approximately 2 inches in depth. Head in top layer within crate, crate in top layer about 2/5 of the length of the chamber towards the rear.

